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APPLICATION OF THE ASSIGNMENT ALGORITHM TO QUARTERMASTER CAPTAINS

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Improved motivation and retention of a high quality officer corps within the Army will depend in part on the quality of the system which matches the Army's force structure requirements with the individual Army officer's career needs. In order to better understand the functioning of the current system and to conduct research on officer career progression, a computerized experimental research facilility was designed and implemented at ARI. This facility (described by Van Nostrand in a report in preparation) allows ARI scientists to experiment with (1) systems for presenting career information and guidance tailored to the individual officer; (2) technology of personnel file review and updating; and (3) other aspects of information system technology.

As part of this experimental system, a job assignment module was designed to allocate individuals to job categories according to each individual's suitability. This assignment algorithm is designed to reflect and be flexible to changes in Army policy and was developed with two potential users in mind:

1) Individual officers who would use it to make decisions in expressing their assignment preferences.

2) Officer Personnel Directorate management, particularly assignment officers, who would use it as an aid in making assignments.

Assignment policies are quantified and individuals' scores for jobs are determined in the following manner:

Step 1. The assignment officers determine the categories of jobs to which individuals will be assigned. (Examples are shown in Table 1.)

Step 2. Easily retrievable background variables which enter into the assignment decisionmaking process are identified. (Examples are shown in Table 2.)

Step 3. The assignment officers rate the overall importance of each of the background variables for each of the job categories, thus setting up a table of weights. (Examples are shown in Tables 3 and 4.)

Step 4. For each background variable, a set of features exists which includes all the possible states which can describe an individual's background in that variable. (Examples are shown in Tables 5 and 6.) Assignment officers weigh each feature for its negative, positive, or null importance for each job category. The weights are consistent within a single variable; the relative importance among variables is reflected in the table of weights set up in Step 3.

Step 5. The appropriate product weights (feature weight x variable weight) summed across all background variables for each job category are determined for each individual officer from the available background data in order to obtain a utility score for each of the job categories. These utility scores are standardized to permit comparison among job categories.

Table 1

JOB CATEGORIES USED IN THE INFANTRY RESEARCH

ROTC instructor (ROTC)
Civilian education (CE)
Long tour overseas (LT)
Short tour overseas (ST)
CONUS command (CC)
CONUS staff (CS)
Army School instructor (I)
Reduction in Force (RIF)

Table 2

BACKGROUND VARIABLES USED IN THE INFANTRY RESEARCH

Assignment history (previous experience) (EXP)
Preference for next assignment (PREF)
Civilian education level (CEL)
Component (COMP)
Manner of Performance (MOP)
Time in service (TIS)

Table 3

WEIGHTS OF BACKGROUND VARIABLES FOR JOB CATEGORIES USED IN THE INFANTRY RESEARCH

Background Variables	Job Categories							
	ROTC Instructor (ROTC)	Civilian Education (CE)	Long Tour (LT)	Short Tour (ST)	CONUS Command (CC)	CONUS Staff (CS)	Instructor (I)	RIF
Preference (PREF)	5	7	8	10	6	8	8	15
Civilian Education Level (CEL)	10	7	6	2	4	5	7	4
Component (COMP)	0	3	1	1	2	2	1	10
Manner of Performance (MOP)	7	10	7	6	7	6	9	10
Time in Service (TIS)	3	5	6	4	5	5	7	4
Assignment History (EXP)	9	10	10	10	10	10	10	2

Table 4

WEIGHTS OF BACKGROUND VARIABLES FOR JOB CATEGORIES
USED IN THE QUARTERMASTER RESEARCH

Background Variables	Job Categories							
	ROTC Instructor (ROTC)	Civilian Education (CE)	Long Tour (LT)	Short Tour (ST)	Command (C)	CONUS Staff (CS)	Instructor (I)	RIF
Preferences (PREF)	5	5	5	3	7	8	7	1
Civilian Education Level (CEL)	9	5	3	3	2	4	6	3
Component (COMP)	3	3	2	2	2	2	2	0
Manner of Performance (MOP)	10	10	5	5	8	6	8	9
Time in Service (TIS)	4	5	3	5	7	5	5	7
Assignment History (EXP)	10	7	5	7	6	7	8	5

Table 5

FEATURES OF THE SIX BACKGROUND VARIABLES
USED IN THE INFANTRY RESEARCH

Assignment History (EXP)

1 = no command, not up for a short tour
2 = two or more short tours or just back from a short tour
3 = zero overseas or 48 months since a single short tour
4 = just back from a long tour
5 = RIF list or one time passover for promotion, overrides other factors
6 = weak or special forces command only
7 = instructor, needs command
8 = instructor, needs overseas
9 = needs a long tour
0 = other

Preference (PREF)

0 = none
1 = overseas
2 = CONUS command
3 = civilian education
4 = CONUS instructor
5 = CONUS staff
6 = equal weight for troop and overseas
7 = overseas slightly higher than civilian education
8 = preferences overridden by being on RIF list

Civilian Education Level (CEL)

1 = less than two years of college
2 = 2 or more years of college
3 = college graduate and/or a year or more of graduate school
4 = master's or professional degree
5 = Ph.D.

Component (COMP)

1 = Regular
2 = other than Regular Army

Manner of Performance (MOP)

1 = upper third
2 = middle third
3 = lower third

Time in Service (TIS)

1 = 95 or more months active federal commissioned service
2 = 80-95 months
3 = 65-79 months
4 = 64 or fewer months

Table 6

FEATURES OF THE SIX BACKGROUND VARIABLES
USED IN THE QUARTERMASTER RESEARCH

Assignment History (EXP)

1 = no command; not up for a short tour
2 = two or more short tours or just back from a short tour
3 = zero overseas or 72 months since a single short tour
4 = just back from a long tour
5 = RIF list or one time passover for promotion; overrides other factors
6 = needs a long tour

Preference (PREF)

0 = none
1 = overseas
2 = command
3 = civilian education
4 = CONUS instructor
5 = CONUS staff
6 = preferences overridden by being on RIF list

Civilian Education Level (CEL)

1 = less than 2 years of college
2 = 2 or more years of college
3 = college graduate and/or a year or more of graduate school
4 = master's or professional degree
5 = Ph.D.

Component (COMP)

1 = Regular Army
2 = Other than Regular Army

Manner of Performance (MOP)

1 = upper third
2 = middle third
3 = lower third
4 = borderline cases between middle and lower third or extenuating circumstances for being in lower third

Time in Service (TIS)

1 = 95 or more months active federal commissioned service
2 = 80-94 months
3 = 65-79 months
4 = 64 or fewer months
5 = over 156 months active federal service

The assignment algorithm has been described elsewhere (Fields, 1977). Briefly, it can allocate officers to job categories in three ways: (1) optimization of scores for assigned job for the total group; (2) preselection of some individuals particularly suited for certain assignments followed by optimization across the remainder; (3) rank ordering of the individuals by their total scores (across job categories) followed by preselection and optimization. The optimization method is based on the Ford-Fulkerson model (Ford and Fulkerson, 1957) modified by the ARI computer center staff (see Granda and McMullen, 1974).

This algorithm was originally developed using the Infantry branch captain assignment procedure (Eastman, 1977). In that research, the algorithm was shown capable of quantifying and objectifying assignment policies and practices of the Infantry career branch and to be both feasible and efficient.

The purpose of the present research was to explore the transferability of the algorithm to other assignment situations.

PROCEDURE

SUBJECTS

Assignment procedures for captains of the Quartermaster Branch were chosen for transferability research. A non-combat arms branch was desired to contrast with the Infantry research.

A sample of Quartermaster captains (N=57), comprising all the members of a Quartermaster Officer Advanced Course, was used to evaluate the assignment module. The officers had to be assigned at one time; therefore it was possible to model procedures of different kinds of assignments in a short time frame. Furthermore, the size of the class was sufficiently large to test the algorithm's ability to make correct assignments.

DETERMINING THE WEIGHTS

The assignment officer for the group was briefed on the purpose of the research before assignments were made for this class of Quartermaster officers. Shortly after the assignments had been made, the assignment officer was provided with background variables and job categories from the Infantry research, and asked to evaluate their applicability to the Quartermaster assignments. The officer was then asked to provide the two tables of weights discussed above incorporating changes, deletions and additions he might judge necessary. This was a slight departure from the procedure in Infantry branch research

reported by Eastman (1977) where weights were assigned before assignments were made. Also, in the Quartermaster branch, one officer both determined the weights used in this research and made the assignments. In the Infantry research, three officers made the assignments although they did so in a joint meeting. Each of the three assignment officers independently made up tables of weights, as did an experienced Infantry assignment officer who was reassigned before the assignments were made, and an officer from the Infantry Advanced School. The weights actually used in the Infantry research were the modal values from these five inputs.

TESTING THE ALGORITHM

The table of weights and the background data of the 57 officer-subjects were entered into the computer and the algorithm was run three times to assign officers by the three possible methods: (1) optimizing total utility scores across the whole group, (2) preselecting officers particularly suited for a particular job and then optimizing the total utility scores across the rest, and (3) rank-ordering the officers before preselection and optimization. In this research approximately half the quota for each job category was allocated for preselection. The rank-ordering method was run so that individuals most qualified for jobs would be preselected before preselection quotas were filled.

These three methods of making assignments were evaluated by determining the match with the actual assignments independently determined by the assignment officer. In addition, because more than one assignment may be appropriate for an officer at a given point in a career, a suitability measure was calculated that had been devised in the Infantry research for computer placements which did not match actual assignments. It was assumed that assignments made by assignment officers meet certain criteria of suitability. The assignment officer was asked to provide one or more equally suitable alternate assignments for those officers whose computer placements did not match the actual assignment. A computer-generated assignment was considered suitable if it matched either the actual assignment or an alternate assignment.

RESULTS

EVALUATION OF INFANTRY-PRODUCED VARIABLES FOR QUARTERMASTER ASSIGNMENT

The Quartermaster branch personnel agreed that background variables and the job categories determined in the Infantry research were also suitable for Quartermaster captain assignments with one exception. It was felt that, for Quartermasters, the continental U.S. (CONUS) command job category was insufficient; therefore the category of command (C) included both CONUS and overseas command. However, because the Quartermaster branch personnel did not feel that the features of the Infantry background variables were in all cases appropriate for Quartermasters, changes, deletions, and additions were made. The Quartermaster features in Table 6 can be compared to those for the Infantry in Table 5.

EVALUATION OF THE ALGORITHM

The percentage of agreement between the actual assignments and the computer-generated assignments for each of the three algorithm methods, shown in Table 7, reflects the success of the assignment algorithm in reflecting branch policies and procedures. For comparison, the percentages from the Infantry research are also given in Table 7.

When the assignment officer was asked to give alternate suitable assignments for those officers whose computer-generated assignments had not matched their actual assignments, a problem arose. In this group, five officers had received assignments based on conditions not reflected in the algorithm--compassionate assignments and special requests (e.g., a General Officer would request that a certain officer be assigned to his staff). In discussions on how these cases would be reflected in the algorithm, it was pointed out that these assignments had been handled outside the normal procedures and probably always would be handled separately despite any future changes in procedure. For this reason, it was decided to remove these individuals from the study and adjust the job quotas accordingly.

Table 7

PERCENTAGES OF COMPUTER ASSIGNMENTS WHICH MATCH THE ACTUAL ASSIGNMENTS OF 57 QUARTERMASTER CAPTAINS AND 160 INFANTRY CAPTAINS

Method of Assignment	% Match Quartermaster	% Match Infantry
Optimization	79	61
Preselection and Optimization	81	(a)
Rank Ordering with Preselection and Optimization	82	58

[a] This method of assignment was not used in the Infantry research.

Table 8 shows the percentage of agreement between the actual or alternate assignments and the computer-generated assignments of the remaining 52 officers. The Infantry figures are given in Table 8 for comparison. The last two columns show the percentage of captains who received a "suitable" computer assignment (one which matches the actual and alternate assignments). Each of the three algorithm methods for Quartermaster captains produced exactly the same assignment for each individual.

DISCUSSION

ASSIGNMENT ALGORITHM VARIABLES

The factors (job categories, background variables, and features) which enter into the decisionmaking process in the Quartermaster branch are similar, but not identical, to those used in the Infantry. This suggests that the algorithm is transferable across branches. It underlines the transferability of the model and the theory behind it--that assignment procedures can be modeled as a system which weights factors and maximizes outcomes. However, it does suggest that transferring the algorithm involves more than changing weights. Unless an Army-wide set of job categories, background variables, and features can be set up, a careful study of the policies and procedures of each branch or division must be made, and appropriate factors as well as weights must be decided upon.

As policies and regulations change, the model must change as well. For example, at one time a Regular Army (RA) commission made an officer immune to RIF; recent changes in the law have made this no longer true. In the assignment algorithm, RA had a large negative weight for RIF until the change; now it has a weight of 0.

EFFECTIVENESS OF THE ALGORITHM

The difference between the effectiveness of the algorithm in matching actual assignments for Quartermaster captains and Infantry captains is shown in Table 8. The improved performance of the assignment algorithm can be explained in large part by the fact that, in the Quartermaster research, those officers whose assignments were made outside of the usual career progression were removed from the research group. This was not done in the Infantry research. Such special cases have a compounding effect in that in the algorithm the number of people must equal the sum of the quotas for the job categories. Therefore when a person was assigned to Category B for compassionate reasons, and the computer assigns him to a job category A slot, not only is he misassigned but also the individual who actually filled job category A, because the computer has already assigned the slot to the first individual.

Table 8

PERCENTAGE OF COMPUTER ASSIGNMENTS WHICH MATCH THE ACTUAL OR ALTERNATE ASSIGNMENTS OF 52 QUARTERMASTER CAPTAINS AND 160 INFANTRY CAPTAINS

Method of Assignment	% Match with Actual Assignment		% Match with Alternate Assignment		% Match with Actual or Alternate Assignment	
	Quartermaster	Infantry	Quartermaster	Infantry	Quartermaster	Infantry
Optimization	96	61	0	25	96	86
Preselection and Optimization	96	(a)	0	(a)	96	(a)
Rank Ordering with Preselection and Optimization	96	58	0	22	96	80

[a] This method of assignment was not used in the Infantry research.

However, this does not account for the difference between Infantry and Quartermaster match to actual assignment shown in Table 7. The Quartermaster branch is much smaller than Infantry branch, so that more time may be spent on an assignment process. Requisitions for Quartermaster officers often outnumber available officers, perhaps allowing for a better fit of job and officer. The identification of factors in the assignment process and their weights may have been more precise in the Quartermaster research because only one assignment officer was responsible for the entire process.

The computer has the advantages of speed, objectivity, efficiency, and consideration of all identified relevant variables. The computer can give branch personnel more time for handling special cases and for evaluating assignments after the computer has done preliminary file reviewing and partitioning. This assumes, of course, an operational system with access on-line to the Officer Master File of personnel data.

The assignment module is visualized as one module in a career progression information system. One way the module might be used is shown in Figure 1. The assignment algorithm would be used in advance of assignment deadlines to produce tentative assignments for officers up for reassignment. These officers either could indicate preferences or query other modules to learn more about possible assignments, then submit preferences for final running of the algorithm, subsequent evaluation, and actual assignment.

CONCLUSIONS AND IMPLICATIONS

The results indicate that the assignment algorithm can be applied to situations other than Infantry branch. The high percentage of computer-generated assignments that match actual Quartermaster assignments suggests that the algorithm can model branch policies and procedures and that the model is improved if special cases, e.g., family hardships or special requisitions, are handled separately as in actual assignment procedures. Adaptation of Infantry variables to the Quartermaster situation underlines the fact that care must be taken to tailor variables to the actual set of procedures and policies modeled either across branch or division or over time. However, the assignment algorithm can be visualized now as a useful ancillary source of information to the assignment officer in making tentative assignments, reviewed and changed as necessary.

In summary, the research with Quartermaster captains has shown that the assignment algorithm is a feasible approach for matching officers with jobs. This approach can be adapted to a small, non-combat arms assignment situation as well as to the large Infantry group for which it was originally developed.

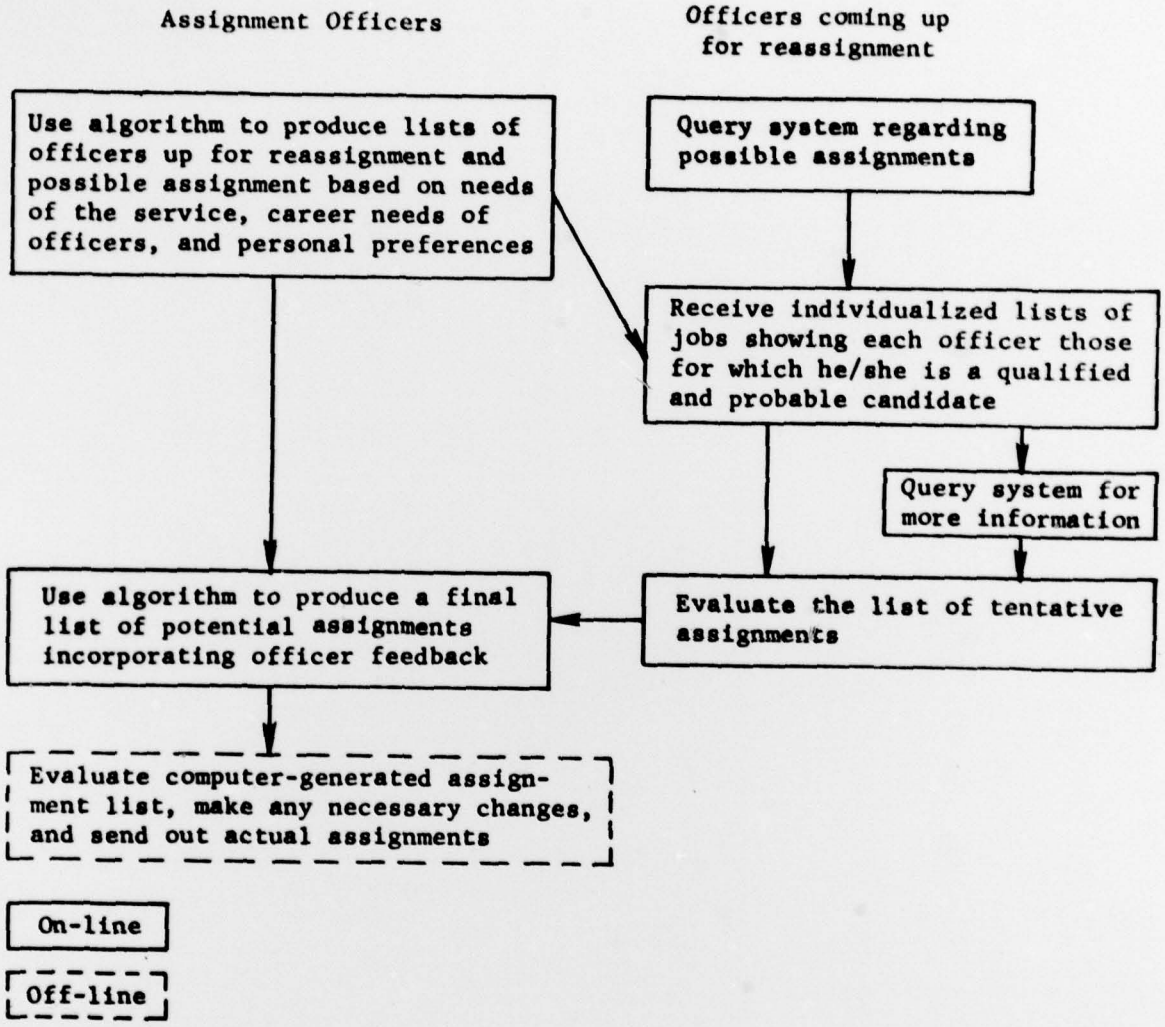

Figure 1. Possible use of the algorithm

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